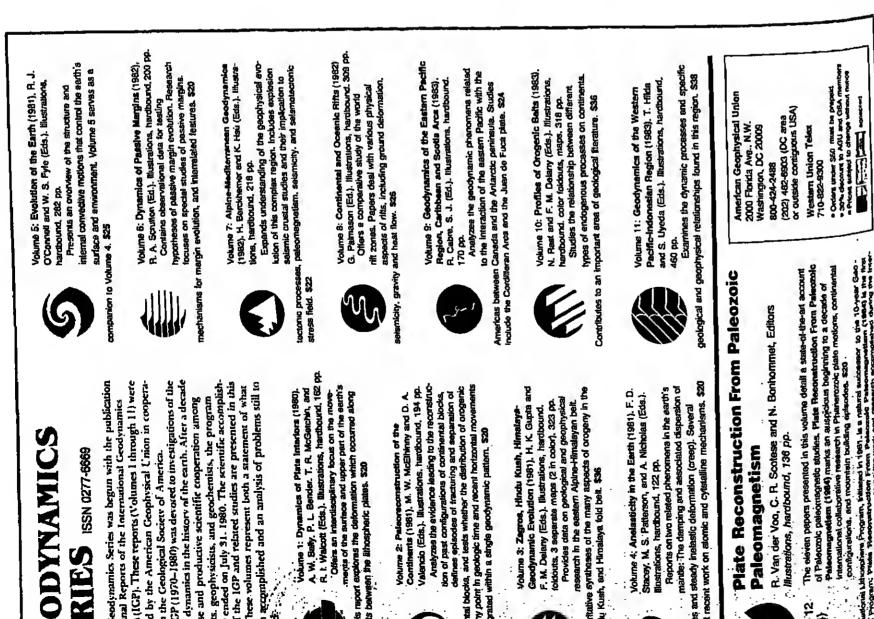


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June 5, 1981



## Sadami Matsushita 1920-1984



Sadami Matsushita, of the National Center for Atmospheric Research, died on March 15, 1984, less than a half year after being told that he had stomach emeer. He was born in Kyoto, Japan, on February 12, 1920, the only son of Kiyomi and Taka Taniguchi Masushita, from whom he acquired his lifelong appreciation of literature and the arts. In 1951,

Maisnshiia obtained his Doctor of Sciences degree from Kroto University where, confinning his research and lecturing, he soon became one of Japan's leading experts on the subject of iourspheric processes. In 1954, on an invitation from the Research Staff of Physics at the Imperial College of London, he spent a year in England, Before returning to is bumeland, Majsushita was persuaded by Walter Roberts to visit the High Abittule Observatory (HAO) at the University of Colorado at Boulder, Colo. The visit became a permaneur 29 years of significant scientific creativity in HAO (which because a part of the Center for Atmospheric Research).

Marsushita's 163 professional publications span 3% years of derlicated research. His speclalty was the ionosphere, in particular E region ionization and currents; about two thirds of his publications were oncerned with the associated geomagnetic topics. He was an editor of two major textbooks, lonospheric Sporadic E (Pergamon Press, New York, 1962) and Physics of Geomaguetic Phenomena (Academic Press, New York, 1967). In a review of this laner book, E. G. Bullard wrote, "Those coming fresh to [geomagnetism] as young men, and their elders who have failed to keep up with current work, will be grateful." Alatsushita contributed 17 chapters to various textbooks and enerclopedias. He was continually invited to review ionospheric and geomagnetie topics at international scientific meetings. He was an active leader in the International

Association of Geomagisetism and Aeronomy, the International Scientific Radio Union, the American Geophysical Union, and the Society of Terresirial Magnetism and Electricity of Japan. He was a fellow of the AAAS, a member of RESA and Sigma Xi, and editor of seceral scientific journals. For many years Marsushina was the principal organizer of the triennial International Symposium on

quatorial Aeronomy. To many fellow scientists, Matsushina's greatest contribution was his dissection of the physical processes involved in the ionospheric purposition, currents, fields, and motions. As part of his professor adjoint post at the University of Colorado Department of Astro-Geophysics, he guided a number of superior graduate students in their dissertations on these topics. Through their research his work continues and grows.

Matsushita's interests extended to Japanese art, music, and history. He was a translator of anciem Japanese writings. At times he advised the Colorado University College of Music concerning their productions involving Japanese costumes, dance, and customs. He enjoyed collecting antique Japanese arrowheads and associated marrial artifacts and wrote schelarly articles regarding their classification and historical significance. He was oceasionally askerl to provide an authoritative appraisal of such froms for unseum collections. His great joy on weekends at international science conference trips was to discover a singular Japaniese autique at some inconspicuous shop. His home its Boulder was almost a miniature museum for displaying his favorite acquisitions. Indicative of his values and seuse of scientific continuity, however, was Matsushita's cherished office adorument: the chair used by Sydney Chapman duritsg his last years at HAO.

Walter Roberts recalls that Mat "... was never too busy to give help and, in his critical but gentle way, he would tell me what he thought was right or wrong about the matter I was trying to comprehent." To all of us who knew him, Maisishita was not only a fine and productive scholar but unfailingly gracious and patient with those who sought knowledge or disagreed with his viewpoint. The world of Isis friends is now a little prore empty with Isim gone. The world of geophysics has profited greatly by his dedicated life-

Contributions to the tax exempt Maisushita Memorial Fund are being accepted c/o University Corporation for Atmospheric Research, D. A. Reynolds, Connutroller, Box 3000, Boulder, CO 80307. It is the pro pose of this fund to publish a buntarl book of selected Matsushita research papers to distribare to all those who contribute \$10 or more.

This bibute was contributed by Wallace H. Campbell, Branch of Global Sermology and Geomagnetion, U.S. Geological Survey, Denvey, CO.

# Yews

## Natural Gas: The **Next Shortage**

The eighth Annual Meeting of the Gas Research Institute that was held in Chicago in April 1984 focused on the potential of a crisis in the supply of natural gas. According to a report of discussions held at that meeting, 'Natural gas, the country's largest permchemical feedsmck, may be in short supply in a couple of years if some present forecasts prove true. The next supply/demand crisis for natural gas is likely to come in early 1986" [Chemical and Engineering News, April 30, 1984]. There are a number of emiables, geologic and socio-economic, that that affect his prediction. An important factor is that drilling exploration of natural gas has decreased sharply, due to the ouser of sharp rates of surplus since 1981. Drilling is highly

sensitive to depth and How rate. Since 1981, a number of gas wells have been shin down, a process that may have damaged their usability in the luttire. New drilling has been for relatively shallow holes that could run out of gas in the next 2 years. Future drilling depends a lot on demand, continuation of deregulation, and costs. The natural gas industry was grained a number of 6-year lease development awards for deep hosing drilling in the Gulf of Mexico. It will take considerable drilling effort to bring these leases into production by 1989, the year they expire. The question now is whether demand will be sufficient to provide the necessary

The reason that a 1986 crisis is predicted by most (but ant all) untural gas company executives and market analysts is that supply and demand are expected in balance out by late 1985. Shortages may begin early 1986. The price of natural gas is expected to rise sharply then, owing to shurtages and to the phases of decontrol and deregulation of die ndustry. The status of wells that may have been damaged due to high pumping rates in the past may be a factor in 2 years. The reopening of shut-down wells may be another

The sad outcome of the present circum stances is that not only will gas prices rise in 2 years, but higher prices will support imports

# New Undersea Research Unit

The first cold-water activity under the National Oceanic and Atmospheric Administra-tion's (NOAA) National Undersea Research Program will begin in the Gulf of Maine in August, according to NOAA Administrator John V. Byrne. The prime objective of the new activity will be 10 survey ocean damping grounds and 10 study the productivity of the area's valuable fish resources. (The World Court is currently deciding on the fishing boundary between the United States and

Canada in and around the Gulf of Maine.) Detailed maps of dumpsites off Portland Maine, and Boston, Mass., will be made, followed by an assessment of the effects dumping has on marine life. Dredge spoil is dumped offshore from Portland; a variety of material—from dredge spoil to munitions—is

dumped off Boston. The new undersea research unit will be opcrated for NOAA by the University of Con-

Other facilities in NOAA's National Undersea Research Program include the Hydrolab

habitat off St. Croix, operated by Fairleigh Dickinson University; the Southeastern Un dersea Research Facility (SURF) with a diving bell and surface vessel, operated by universities from Virginia, North and South Carolina, and Georgia; and a University of Hawaii prograin that uses a small submersible.

## Seismologists to Map the Mantle

A. Dziewoński and J. Woodhouse of Harvard University have developed new seismic models of the carth's mantle, according to a recent report. The calculations are the results of attempts to obtain three-dimensional seismic structures of the mande. The forumlations are mathematical his to seismic data, essentially with me major bitial assumptions as to mainle structure. That the model has leatures that correlate with known crustal and mantle properties has been reassuring. The report quotes Woodhouse, "This makes other panerns discovered in this study highly believable" [Research and Development, May 1984). A first finding of the model is related to the homogeneity question of the upper and lower mantle regions. Dziewonski said, ". . . at this point trat' maps show little continuity between the upper and lower mantles."

Other lindings of the new models involve the roots of continental structures, which in South America and Africa extend into the transition zone to depths of about 600 km. The new models may be limited to previ-

ous compilations of the seismic properties of the mantle by Dziewouski and colleagues under the acronyms of PEM, PREM, etc. In PREM, which refers to the preliminary reference earth model, an attempt was made to develop a parameterized appruach and, as in the field of geodesy, compare a reference model in analogy with the reference ellipsoid.
The result has been met with broad acceptance. The analogy of attempting to parameterize normalized functions strictly holds true only in terms of seismic coefficients (Vp,Vs), and less so for (Qu,Qk). Radius must

be obtained from geodesic models, and densi-ty must be fit to models of velocity gradient whose exactness varies, particularly at discontinuities where detailed data may be unavailable (A. M. Dziewonski and D. L. Anderson, Plusies of the Earth and Planetary Interiors, 25, 1981. Among the revelations of PREM nre interpretations that the low velocity zone in the upper manile is probably due to anisotro-py, the result of preferred orientation of nuneral crystals (ollvine and pyroxene). Thus, the low velocity zone may not be due to a

heated zone as previously thought.

Anderson extended the model-making effort recently and called his approach "earth tomography" (See Eas, April 17, 1984, cover, and Mny 8, 1984, p. 346; also see Science, 223, 347–355, 1984). He described the analogy with medical practice as follows: "...technique similar to medical tomography being used for imaging with seismic body and surface waves." There is a departure from the PREM approach in that geochemical reason-ing and calculated mineral properties were fed into the modeling procedure. A conclu-sion was drawn that olivine mineralogy (actually, olivine chemical component or stolehi-ometry) was not dominant in the earth as would be the result of having pyrolite model compositions in the manule. According to Anderson, "The transition region, therefore, appears to be mainly garnetite, rather than oliv-

ine and its high pressure forms." The consequences of this model and of

PREM are that a number of standard assumptions about the earth's interior may be questioned. That the law velocity zone in the upper mainle is not a high-temperature zone could affect thermal models of apper mantle convection mechanisms, and that the 400-km seismic discontinuity is not mainly due to the olichie-spinel transition, and, indeed, may nor be a valid discominiour arall, could be dilhcult to accept in the context of Jamilian mod els of the transition zone. There is essentially no olicine equivalent conquirem in the transtion zone and lower mantle, yielding a perinskite lower mantle that would mean that 80% of the earth's volume was made of sile

cité perovskite. How are we in know how to interpret Dziewoński and Anderaon's models and their soon-expected derivatives. Aside from pure reference data m.e., seismic velocities coordi nated with the earth's radial distances in three dimensions) the consequences are at present subject to the uniqueness of interpreiation and to the validity of physical properties of mantle minerals calculated over great depths in the mantle. Ground truth for these nterpretations lies in extensive seismic data. Ground truth outst also lie in radial mineral data for the intense conditions of the mantle. The newly emerging field of mineral physics will have to supply this truth.—PMB

## **Acid Rain Study** in Gulf of Mexico

As part of the continuing investigation into the sources and mechanisms of acid rain, a research project sponsored by the National Oceanic and Atmospheric Administration (NOAA) will attempt this summer to find out if natural substances blowing inland from the Gulf of Mexico might be partly responsible for the acidic rain that afflicts the midwesters and eastern United States.

A research team flying a Beecheraft twin-engine airplane will sample air quality at vari-ous points offshore, along the Culf Coast, and inland to measure concessivations of chemicals that are "acid precursors." These precursors-sulfate, sulfur-containing gases, and alkaline materials—form naturally in the Gulf, its estuaries and coastal wetlands, according to the project's principal investigator, Rudolf F. Pueschel of NOAA's Environmenial Research Laboratories. The chemicals rise into the atmosphere and are carried inland by oushore winds; the NOAA study group would like to know more about their concentration as they muve northward over the con-

During periods in the summer when stalled high pressure areas in the Gulf and off the Atlantic const of Florida are forcing air masses inland, the research airplane will lly sans-pling missions twice daily. The plane is outfu-ted for trace gas analysis, cloud and rainwater collection, and measurement of aerosol size distribution and elemental composition. Tise flights will run parallel to the coastline at a distance of roughly 30-50 km offshore, as well as along the coast and at various dis-tances inland (depending on bow long the winds blow onshore). Samples will also be taken from within offshore clouds to collect data on how these clouds accumulate chemical compounds from the water.

The flights will originate from points be-tween Corpus Ghristi and Houston, Tex., and from Mobile, Ala., east across the Florida panhandle. "Selection of these areas [where onshore winds can blow for 2-3 days] fol-lowed examination of weather conditions in

the Gull for the past 5 years," according to Preschel, The Gull of Mexico study is part of the National Acid Precipitation Assessment Program, a multi-agency investigation of acid rain, and is being conducted by the Air Resources Laboratory, part of NOAA's Environmemal Research Laboratories in Boubler,

## In Congress: **Upcoming Hearings**

The following hearings and markings have been tematively selectuled for the coming weeks by the House of Representatives. Dates and times should be verified with the comminee or subcomminee hidding the hearing or markup; all offices on Capitol Hill may be reached by telephonoug 202-224-3121. For guideliner on contacting a member of Congress, see AGU's Guide to Legislative Information and Contacts (Ens. April 17, 1984, p. 159).

June 14: Conference committee on the Export Administration Act reauthorization tS.
979). Capitol Building, Room S-207, 2 P.M.
June 25: Hearing on the National Minerals
and Materials Policy Coordination Act (H.R.
9717) by the Mining, Forest Management,
and Bonneville Power Administration Suband Bonneville Power Administration Subcommittee of the House Interior and Insular Affairs Consuittee. Longworth Building. Room 1824, 9:45 A.M.

June 26: Hearing on legislation subjecting he Coastal Zone Management Act (P.L. 94-370) to federal consistency provisions (H.R. 4589) by the House Merchant Marine and Fisheries Committee. Longworth Building. Room 1884, date and tinse tentative.-BTR

# Mapping the EEZ

A cooperative, middi-year program to map the largely uncharted Exclusive Economic Zone (EEZ), begun last month, has the potential for piggybacking scientific observations and research. On March 10, 1983, President Ronald Reagan proclaimed the mineral-rich zone as the area between the U.S. shoreline and 200 nautical miles outward. The United States has sovereign rights for exploration. exploitation, conservation, and management of all living and nonliving resources within the zone.

The National Oceanic and Atmospheric Administration (NOAA) and the U.S. Geological Survey (USGS) will cooperate in the project that will map an area nearly twice the rea of U.S. land. USGS responsibilities indude definition of seaflnor geology and definition of geological processes and resources, including sand and gravel, placers, phosphuntes, manganese nudules, cobalt crusts, and sulfides (Eos, March 20, 1984, p. 105). NOAA, meanwhile, will be surveying, mapplng, analyzing resources, and managing lish-

Mapping began in the Pacific near Cape Mendocino, Galif. The west coast will be surveved this year and next, followed by Alaska in 1986, the Hawalian Islantis in 1987, and the trust territories after that. No schedules have yet been set for the east and Gulf coasis.

NOAA and the USGS are encouraging the piggybacking uf observations and sampling in related areas during the data-gathering cruises. For additional information, contact Adm. John Bossier, National Ocean Service, NOAA, 6001 Executive Blvd., Rockville, MD 20852, or Terry W. Offield, USGS, 915 Nailonal Center, Reston, VA 22092.--BTR

The History of the Earth's Crust, D. L. Eicher, A.

L. McAlesier and M. L. Rottman, Founda-

tions of Earth Science Ser., Prentice-Hall, En-

son aml L. H. Shehlon, Prentice-Hall, En-

glewood Cliffs, NJ, x + 326 pp., 1984.

ххх + 412 рр., 1984, \$79.50.

The International Karakovam Project vol. 1, K. J.

International Society for Roch Mechanics, Inter-

International Society for Rock Mechanics, Inter-

2. Melbourne, xxxiii. + 841 pp., 1983.

The Legal Regime of Fisheries in the Caribbean

Region, W. R. Edeson, and J. F. Pulvenis,

Lecture Notes on Constal and Estuarine Stud.

Mesocale Meteorology: Theories, Observations and Models, D. K. Lilly and T. Gal-Chen (Eds.).

D. Reulel, Hingham, Mass., x + 781 pp.,

Sawkins, Minerals and Rocks, vol. 17, Spring-

er-Verlag, New York, xiv + 325 pp., 1984,

Migmatites, Meltung and Metamorphism, M. P.

col. 7, Springer-Verlag, New York, x + 204

national Congress on Rock Mechanics, vol.

l. Melbourne, xxx + 689 pp., 1983, \$250.

national Congress on Ruck Mechanics, vol.

Miller (ed.), Cambridge Univ., New York,

# the Numerical Solution of Differential Equations

J. F. Botha and G. F. Pinder, Wiley-Interscience, New York, 202 pp., 1983.

Reviewed by J. A. Liggett

This book is relatively short, about 200 pages, organized into seven chapters. The first chapter sets the scope and adjectives and contains a dote on notation. The next chapter contains the fundamental concepts that are the key to the presentation and the authors' philosophy on immerical methods. Chapters 4—G reat elliptic (Poisson's equation), parabolic tille diffusion equation), and hyperbolic partial differential equations, respectively. The last chapter shows the solutions of certain cases with singularities and nonlinear behavior. The boundary element method is briefly discussed in chapter 4; the method of characteristics is discussed in chapter 6.

This book brings a much needed unifying point of rier to the methods of finite differences and buite elements. The authors (reatboth methods from the perspective of using interpolating polynomials. The links element method is solved only with the method of weighted residuals, which in turn uses only Galerkin and collocation recliniques. It is refreshing that the book makes valid cooparisous beween timite differences and finite elements. Finite differences are not dead and are not to be completely replaced by finite elements. At the end of each chapter the anthers provide a sumpary which overs the main conclusions of the chapter. This summany often points to the relative advantages and disalvantages of the methods in the chapter. This sort of guidance is, untormnately, rare among books deading with numerical methods, and its appearance in this book is most reclaime.

There appears to be two kinds of books on numerical methods: the "low-to" loads that explain the elements of numerical solutions. and attempt to instill an intuitive feel for the process and the "analysis" type that explains how numerical methods bruction on a mathematical lasis. Most engineers and applied scientists have little time for the second type. perhaps to their deniment. This book appears to straddle the lence between these two trices. How well the authors manage this balancing act is dependent on the reader's point of view. Few students who are learning numerical methods, especially with the goal of applying them to practical calculations, could appreciate detailed mathematical analysis. On the other hand, the malest bright become impatient with some of the elementary explanaitous. The brook tends to be most valuable for those who already know practical numerical methods, esnerially those who learned it in a hardrazard way, in that it unifies some of the recliniques, compares methods, and parts dent on a common ground. From that point of view I thoroughly enjoyed reading this

The authors state on the book cover that it can serve as a text in graduate or undergradnate courses or as a reference for engineers, research scientists, numerical analysis, ami computer programmers. In sessing rhat audience the book seems to have a number of shorrcomings. It is written rather unevenly. assuming in some parts that the reader is a

Fundamental Concepts in meophyte in munerical methods and mathematirs, and in other parts that the reader has considerable knowledge. In separate places there are explanations of the classification of partial differential equations and Gaussian madrature (withmu treating the significance of the bruner or the basis of the latter) which must be elementary to a similent who could read and understaint the difficult section on consistency, stability, and convergence. The authors point out that the book is free from specific engineering and scientific jargon but unsi compensace by including considerable mathematical jargon which will be a himdinnee to most engineering and applied science students. There are examples in each chapter and problems at the ends of the chapters, but these are of a mathematical nature and would not serve to motivate the applied student. Early in chapter 2 there are two theorem-promis (thise most hated artilacts from tome long forgotten madematics course), but nooe in the remainder of the

The untation is a minor point has somewhat annoying in my realing of the book. Differentialing is symbolized by a capital Dwith a subscript denoting partial differential tinn and a superscript denoting the order, I often found myself turning back pages to lind the definition of symbols. In a few places the symbols appear in have multiple meaning. For example, the short section on Gaussian quadrature uses a for weights and a for sampling points, exactly the same as used in the immediately previous section for area and nodal coordinate. Also, no accasion some of the mathematical or numerical jargon is madelined or defined after the print of first usage. There are a number of places where the authors muld have made the book more

The reader pousi constantly keep in mind the limitations of this book. The authors have not attempted a comprehensive text in terms of problems, examples, or numerical recliniques. That fact is apparent in the three chapters on elliptic, parabolic, and hyperbolic equalibus. It was upist appearent to me in the typedadic drapter, which harely mentions in single, unumbered equation only nite linite difference implicit scheme. The Galerkin method is deemed musatistactory for hyperbalic equations without mention of the Galerkin-Petrov technique. Reasonably frequent references to the literature do not compensate for the omissings

Owing to the above mentioned limitations, cannot recommend the bonk as a text, nice of its stated objectives. I would, however, highly recommend it to those interested in, and with some previous knowledge of, numerical methods. It would, judged, he a rare reader who would not learn and hencia from

J. A. Liggett is with the Department of Environmental Engineering, Connell University, Ithaca,

## Arctic Energy Resources: Energy Research

Louis Rey (Ed.), vol. 2, Elsevier, New York, 1983, x + 366 pp., \$78.75.

Reviewed by George Cryc

Arctic Energy Resources is a volume of 26 pa-

pers recording the proceedings of the Co-**MAGNETIC** 

# RECONNECTION In Space and Laboratory Plasmas (1984)

Geophysical Monograph Serles

Volume 30

E. Hones, Jr., Editor \$33 408 pages · hardbound · illustrations

Bosed on the 1983 AGU Chapman Conference on Magnetic Reconnection, this volume offers a thorough examination of the subject area. A strong balance is made between review papers, those which describe basic principles, and papers on recent theoretical and observational advances. Of special interest is major new magnetospheric observations made by the ISEE 3 satellite. A question and answer session held during the Chapman Conference as well as an appraisal session are included in the last section of the book.

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mite' Arctique International Conference, hebl at the Venius Centre, Oslo, Norway, September 22-24, 1982. This was the fourth of a series of meetings on the Arctic organized by the Comite', an organization established in the Principality of Monaco with the active support of H.S.H. Prince Rainer III. The fourth Conference was opened by H.R.H. Crown Prins Harald of Norway, a unble be-

ginning for a noble objective. The North Polar Region has drawn world attention recently because of several large livdrocarbon and other mineral discoveries and because of major political and environmental actions in the North American Arctic. Since 1923 when Naval Petroleum Reserve number 4 (NPR-4) was established, myrthern Alaska has been considered a major petroleum pror ince. It was first explored systematically with modern techniques from 1943 to 1953. In 1958, Alaska became a state, and both federal and state lands in northern Alaska were available for private exploration. Building on the knowledge base provided by the let-4 program and its spinoff research laboratory at Barrow, industry explored the area east of NPR-1 and discovered the largest hydrocar-

on accumulation (9.6 bbl cruite oil and 26 Tel (trillion cubic feet) gas) in North America at Prudhoe Bay, Concerns for environmental in pacts, including oil spills, led to the passing of the National Environmental Policy Act in 1969. In 1970, over 9 million acres were ser aside, now known as the Arctic National Wildlife Range, and in 1971 the Alaska Native Claims Settlement Act was passed by the U.S. Congress. The Arab oil embargo of 1973 heightened the energy crisis and changed the economic basis for further exploration in the Arctic. The convergence of these events dramatically changed the balance of power and the pace of activity in the

North American Arcic. Since the Prudhoc Bay discovery, additional perroleum resources of a few billion barrels of crude oil and nearly 25 (Tcf) of gas have been discovered on the Nurth Slope of Alaska and adjacent Canadian Arctic reginus both oushore and offshore. I'et-4, now the National Petroleum Reserve in Alaska, has undertone another exploration program and has been onened to leasing. Base metal deposits have been produced in the Canadian Arctic for many years and a new world-class lead and zinc province has been defineated in the Brooks Range of Alaska. Coal resources on the North Slope may be equal to or exceed those of the rest of the United States combined. Proposals are being debated currently in the U.S. Congress that would establish a U.S. Arctic Science Policy and provide a

mechanism for continuing research. All of these events have had and outtime to have worldwide impacts. Conferences such as the one recorded in this volume help idenlify problems and provide summaries of current knowledge of the Arctic.

Contributions in the conference came Ironi nine nations and did not include the Soviet Union. These comributions cover nearly all aspects of the subject, ranging from history and philosophy to environmental ethics, from descriptive geology to plate technics theory, and from drill rigs to submarine tankers. This volume of state-of-the-art summary papers would be useful, particularly in government heads, politicians, managers, and other decisionniakers on Arctic issues. However, it would serve only as a begluning or review for the researcher will more focused interests. The volume is organized in four parts that presumably parallel the sessions of the Conference; section 1, Opening Session; section 11, Occurrence of Energy Resources; sections 111, Technological/Economic Aspects of Exploration/Exploitation of Arctic Energy Resources; and section IV, Environmental and Social Impact. The papers in the first section by Louis Rey and Tore Gjelsvik are fascivaling and very instructive. In about 25 pages rhey summarize the history, geology, reources, environmental problems, and socioecommic impacts of Arctic energy resources and development. Rey's encyclopedic grasp of a wide range of scientific disciplines and his telegraphic but nearly poetic writing style make for instructive and yet enjoyable reading. These papers should be required reading in the several seats of government, especially Washington, currently wrestling with questions of policy and operations in the Arctic.

Geologists and geophysicists will be interested mainly in section 11, about 14b pages. In which five authors set the framework geology, describe the petroleum and coal reserves, and project the potential resources. The papers on Arctic North America and Greenland by Nassiehuk and on the Soviet Arcile and Subarctic by Meyerhoff ore particularly well done, with good illustrations. Although they are but brief summaries of very large areas, both have extensive and useful references for further reading. Meyerhoff, a U.S. consultant geologist, has prepared again an excellent summary of Soviet energy re-

sources and related geology.

The next two sections, about half the volume, record 17 short papers on a wide range f technical (engineering), economic, environmental, and social aspects of Arctic energy, re-

sources. There is a little bit of everything. useful commentaries, but not summaries of any one subject. To be sure, these are all vers important aspects of the problem and these papers in provide a wide-angle view with ocensional highlights.

Arctic Friergy Resources is a well-produced bank with good quality paper, very legible type, and upstly good illustrations. As a library source book, it is worth the price.

George Grye is with the U.S. Geological Survey, Menta Park, UA 94025.

## Chemical Hydrogeology

William Back and R. Allan Freeze (cdr.), Benchmark Pap. in Gool., vol. 73, Hutchimon Ross, Strambsburg, Pa., sv + 416 pp., 1983.

Reviewed by C. W. Fetter, fr.

We hydrogeologists have waited for many years and some 70 volumes of the series of Benchmork Patiers in Godogs (Hutchinson Ross) for a delimitive review of the theoretical development of hydrogeology. Our patience has been rewarded with two volumes, Physical Hydrogeology (edited by R.A. Freeze and W. Backt and Chemical Hydrogralogyl. From a his porical perspective, this appears to be a logical division of the subject. The two branches of hydrogeology evolved along separate pathways for many years. In the 1960's the influ ence of the groundwater flow regime on the geochemical mature of groundwater was line described in a qualitative way. In a 1970 Meinzer Award-winning paper, the synergisms of groundwater flow, chemical therms dynamics, and mineral equilibria were elaently described by Hack and Hanshae. The 1970's saw mass transport equations developed wherely physical flow of groundwater and transport of conservative solutes were quantitatively linked. Churent research driver by the need to understand contaminant transport and attenuation mechanisms in groundwater is so linking physical and chemical bydrugedogy that bibite review volumes may not be so conveniently divisible as these.

Chemical Hydrogeology is divided uno live sections, with a total of 29 papers reproduced, some in their entirety and others which have been excepted. The papers in clude their original lists of references, although some citation lists have been shortented if only a pair of the original paper was reproduced. Early servicer is prefaced by venments by the editors giving their perspective of the development of that particular aspect of chemical hydrogeology. These comment sections are rightly endowed with reletences to papers, many of which can also be considcred classics in the field. Some al these cited papers were not long to be included in the review volumes while others are importantiestbroks. All of the papers reproduced in Chemcol Hydrogeology are related to North Ameri-

Part I commins nine papers published dur ing what the edions term the evolutionary period. An additional 11 papers are cited by the edities in their comments. The evolution ary period papers include those dealing with ways of representing the results of chemical analyses as well as presenting some basic by

drogeochemical reactions. Part II deals with the occurrence and gen chemical significance of salt water and contains seven selections. The editors have included a thorough discussion of the hinorial development of the body of knowledge in this subject, viting an additional 49 references. The topics of the papers include salt water intrusion, membrane properties of shale, saline water in marine sedimentar) rocks, and Reochemical reactions involving the mixing of fresh and saline waters.

Pari III examines the equilibrium approach to the study of chemical hydrog ogy. The revolutionary aspects of this topic are highlighted by six articles and backed up by 38 citations in the editors' comment section. The papers primarily examine carbonare equilibria but one paper addresses the equilibrium chemistry of iron. A computer program for calculating chemical equilibria it. also described in one paper.

Isotopes in groundwater is the subject of part IV. Three papers are included, and they discuss carbon 14 duting of groundwater, state ble isotope studies and one of our carbon state. ble isotope studies using hydrogen ond oxygen, and studies involved with the compatison of the ratio of tritium to stable oxygen isotones. An additional 21 articles are oled by

the editors. Heat and mass transport in flowing groundwater form the basis for the fifth and this final section of Chemical Hydrogeology. This section contains three papers and a portion of a review article. The editors cite 17 additions of a review article. tional papers published between 1958 and 1976. This final section is an area of purch eurrent research interest to hydrogeologists.
It brings us up to the status of work which was done through about 1974. This lag in time is in keeping with the concept of the Benchman's Depth of the Concept of t Benchmark Paper series, but it does leave the

reader with the desice for some presentation **New Publications** of the most up-to-date knowledge in this

do note that "one topic of great significance

ciem detail is the chemical hydrogeology of

contaminated systems." I concur with this as-

session and regret that space for two or

three seminal papers on this topic was not available. This would have nicely completed

the section on heat and mass transport. De-

spite this shortenming, Chemical Hydrogenlogy

is an excellent review volume. It is suitable as

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graph shows an necurrence of framboidal

magnetite in the Essebi CM carbonaccous

neteorite. Notice that the magnetite crys-

tals making up the framboid are very uni

form in size, being 0.6-0.7 µm across. Al-

hough somewhat malformed, these crys-

tals show well-developed crystal faces.

ferrestrial framboids, both pyrite and

iron oxides, seem to require low-tempera-

ture aqueous environment for formation.

here and seen so far in only eight of the more than 2000 meteories is thought to

be the result of low-temperature alteration

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tion occurred very shortly after the forma-

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Essebi, Bells, and Haripura CM carboua-

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5pecial Doctoral Research Assistantships. The Department of Oceanography of Old Bosonical University has several special doctoral rewarch assistantships available for Eall Semester, 1984 and 1985. These carry a superi of \$7,000 per academic year, renewable for three years. Applicants with M.S. degrees qualify for waiver of turbion. Students interested in obtaining the Ph.B. in the areas of bindrich themical temperature and turbion to the product of the interesect in obtaining the PDAT in the areas of the high also themicals geological, or playstal to eating table should send an introductory resume to Ur. Romald E. Johnson, Graduate Program Director, Department of Decamography, Did Dominion Uversity, Norfolb, VA 25508.

Did Dominion University u an allumative action

# <u>Meetings</u>

## Announcements

## Call for Papers: 31st Pacific NW Regional Meeting

The \$1st Pacific Northwest Regional Meeting of the American Geophysical Union will be held September 7-8, 1984, at Oregon State University, Corvallis, Oregon. The conyenors are Robert A. Duneau and Shaul Levi The meeting will comprise a large general session plus special symposia on the first re-port of Alvin submersible diving on the Juan de Fuea Ridge and continental margin of Ot egon and Washington, volcanism and plate tectonic evolution of the Pacific Nurthwest, marine geology, and geophysics.

Deadline for abstracts is August 1, 1984

To submit an abstract, follow the standard AGU furmat printed in Eos, January 10, 984, p. 15, 1f you requite a sample of the formal call the AGU Meetings Oppartment a 202-462-6903. Please send original and two coples to Robert A. Duncan, PNAGU, College of Oceanography, Oregon State University, Corvallis, OR 97331 (telephone: 503-754-2296).

A bargain package for ments and accom-nodations is available through the university. and the sessions will be held on campus at the Siewari Conference Center.

Two field trips are planued to the Western and High Cascades of central Oregon. The first (September 6) will visit the Western Cascades, and the second (September 9, 10) will Transect the Cascade Volcanic Arc from west to east. The cost of the field trips will be minimal, including transportation. Information on field trips and accommodation at the necting will be provided to each registrant.
Registration for PNAGU is \$15, and the registration deadline is August 15, 1084. For more information please contact Robert Dun-

## **Groundwater Conference**

July 25-24, 1984 Eastern Regional Groundwater Conference, Newton, Mass. Sponsor: National Water Well Association Teelinology Division. (Alice Viekerman, National Water Well Association, 500 W. Wilson 8ridge Rd., Worthington, OH 43085; tel.: 614-846-9355.) The conference will include sessions on

groundwater contamination and remedial action; groundwater and contantinant flow through fractured rock; geophysics applied to groundwater investigation; and two gener-

## **Water Resources** Management

July 29-31, 1964 Conference on Educational Prerequisites for Water Resources Management, Baton Rouge, La. Spousnr: Universities Council on Water Resources, (Yacov Haimes, Chairman, Systems Engineering Dept., Case Institute of Technology, Case Western Reserve University, Cleveland, OH 44106; tel.: 216-368-4492.[

The program and activities of the conference reflect two major topics: the growing concern over the impacts of the present state of education on water resource management, focusing on the ramifications of recent studies on education; and the growing challenges in water resource education focusing on a reexamination of the 1975 annual meeting. which had as its theme "The Challenge of Water Resource Education."

A trip to the Louisiana World Exposition in New Orleaus, La., is being planned following the conference.

## Moon's Origin

Oct. 13-16, 1984 Conference on the Origin of the Moon, Kona, Hawaii. Sponsors: Linar and Planetary Institute, Division for

Planetary Sciences of the American Astronomical Society, (Paur Jones, Lanar and Plan-etary Institute, 3303 NASA Road I, Houston, TX 77058.)

Abstracts are due July 15, 1984. The goal of the conference is to assess presem understanding of hunar, and hence planetary, formation. Fentative session topics for contributed talks include the chemical, petrologic, geophysical, and dynamical constraints that can be placed on the mounts origin; and new experiments and observations that could help constrain the origin of the manu.

A proceedings of the conference will be published in back form; papers will be due December 15, 1984.

## Illinois Lakes and Watersheds

Nov. 8-9, 1984 Illinois Lake and Water shed Management Conference, Springlickly III. Spousors: University of Illumis Water Resources Center, AWRA Illinois action, North American Lake Management Suriety, (Glenn Smut, Water Resources Center, University of Illionis at Uthana-Champaigo, 2535 tlydrosystems Laboratory, 2018 North Romine St., Urhana, 11, 61801; tel.: 217-333-05364

The deadline for abstracts to be submitted

in triplicatet is July 13, 1984. The conference is designed to being together technical and nontechnical persons to facilitate protection and management of lake and watershed resources in Illinois. Comribnucl and invited papers will be presented on lake and watershed incuragement techniques and experiences; initiation and implementation of lake and watershed management programs on the local level; yesis and benefits of lake and watershed management; take and watershed assessment and classification methods and results; reservoir design and operation to prevent prodems; and research and program acces

A proceedings of all papers will be jublished. Written papers should not exceed 10 double-spaced pages and should be submitted by October 18, 1993. hy October 15, 1984.

## Urban Climatology

Nov. 26-30, 1984 WMO Technical Con-Terence on Urban Climatology and its Appli-cations With Special Regard to Tropical Aceas, Mexico City, Spansons: World Meteoralogical Organization, World Health Organization, Cl. R. Oke, chr World Climate Program Dept., Wurld Meteorological Organization, 41. Chrseppe-Motta, Case postale No. 5, CH-1211 Geneva 20, Swizerland.

Abstracts (less than 500 words) are dite Joly 15, 1984.

Tupics relevant to the meeting include all aspects of orban dimutulogy (processes, effects, models, methods, case middes, especially those relating in urban applications (hazards, health, comfort, air polluiun, energr and water conservation and one, for example) to urban planning (climate factors in siting, layout, and operation of settlements) and to

## New AGU Science and Policy Lecture Series for Universities

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For complete details on the Science and Policy Lecture series and a list of current lecturers and lopics, contact:

American Geophysical Union Members Program Division 2000 Florida Avenue, N.W. Washington, DC 20009 (202) 462-6903

# Meeting Report

## Practical Approaches to Earthquake Prediction and Warning

The title chosen for this renewal of the U.S.-Japan prediction seminar series rellects optimism, perhaps more widespread in Japan than in the United States, that research on earthquake prediction has progressed to a stage at which it is appropriate to begin testing uperational forecast systems. This is not to suggest that American researchers do not recognize very substantial gains in under-standing earthquake processes and earthquake recurrence, but rather that we are at the point of initiating pilot prediction expenments rather than asserting that we are prepared to start making carthquake predictions in a runtine mode. For the sixth time since 1964, with support

from the National Science Funndation and the Japan Society for the Promotion of Science, as well as substantial support from the U.S. Geological Survey (U.S.G.S.) for participation of a good representation of its own scientists, earthquake specialists from the two countries caute together on November 7-11, 1983, to review progress of the recent past and share ideas along promising directions for future efforts. If one counts the 1980 Ewing symposium on prediction, sponsored by amunt-Doherty Geological Observatory, which, though utultinational, served the same purpose, one linds a continuity in these interchanges that has made them especially productive and stimulating for both scientific communities. The conveners this time were Chris Schulz, Lamont-Doherty, for the United States and Tsuneji Rikitake, Nihon Uni-

versity, for Japan. The lormat of the seminar was similar to that of the past: 3 days of formal papers and discussions, lidlowed by a lickl trip, this time a day and a half in Tsukuba Science City. In Tsukuba, the American delegation had the opportunity to rish the facilities and discuss their research with the staff members of the Geological Survey of Japan, the Geographical Survey Institute, the National Research Center for Disaster Prevention, and the International Institute fur Seismology and Earth-quake Engineering of the Building Research

Only sume highlights of the meeting can be offered in this brief report. The papers presented will be published as a special issue of Earthquakes Prediction Research.

The participants left the seminar filled with enthusiasm that we have made real progress toward the goals of our prediction research programs. Though we seem far from being able to make highly accurate short-term predictions, we are able to give reliable assessmens of the likelihood uf occurrence of strong earthquakes in some seismic 20nes on a decade-long time scale. This advance, in turn, will make it possible for us to focus our efforts to do short-term preductions in those places where a major event is most likely within the foreseeable future. There is nothing to indicate that the search for an operational prediction technology will be other

than a long, arduous research task. Progress in understanding the seismic cycle, at least within plate boundary seismic zones, is reflected in the convergence of the processes called "seismie hazard assessment" and "long-term earthquake prediction." The former once implied the study of the seismic climatology of a region, leading to estimates of the strungest earthquakes to be expected and their average frequency of recurrence. Now the combination of geological evidence of prehistoric activity, historical records of earthquakes, observations of contemporary seismicity, and measurements of current cristal movements make possible rather detailed probabilistic statements, admittedly strongly model dependent, about specific future earthquakes. Such statements are the basis for planning buth further scientific studies of the phenomena and disaster

of Quaternary faulting to provide a basis for long-term predictions for the Inland

It has been found, for example, that the

(intraplate) part of the country.

mitigation measures. More than half of the 38 research papers in the seminar were deroted to some aspect of such long-term In addition to the seismulogical and geodetic ubservations related to identifying und evaulating regions of increased seismic potential (seismic gaps), a strong geulogical compunent was reflected in the papers presented. The pioneering work of American geologists like R. Wallace and K. Sieh has emoustrated the validity and the importance uf the interpretation of the displacement histury of a fault during the past few thrusand years or more from geological evidence. An ambitious trenching program is points out that there were no clearly in progress in Japan, and the data being acquired ore being combined with evidence

Tanna fault, at the northern end of the 1/11 Peninsula, ruptures with an average interval of 700 years, the last time in 1930. The Seuva fault in north-central Houshu had not experienced a major break for at least 3000 years prior to the great corthquake of 1890; These numbers illustrate the extreme difficulty encountered in trying to narrow the time of occurrence of future intraplate events. Another study of Quaternary laulting has led to the conclusion that the familiar recurrence relation,  $\log N = u - bM$ , between cumulative number of earthquakes with magnitude greater than or equal tu M and the magnitude, works for all of the seismicity in a region, but not for activity on an individual fault.

Kanamori addressed the question of the possibility of the uccurrence of a strong earthquake in a subductiun zone at which young lithosphere is being slowly subducted. He tested an empirical relation between earthquake magnitude, age of subducting seafloor, and rate of convergence for an "end member" event, the earthquake of May 26, 1983, uff of the coast of Akita Prefecture, in the Sea of Japan. The fit ul this event in the relationship has led him to speculate about the possibility of a very strung event, M8.5, in the zone of subduction of the Juan de Frica Plate under Washington and Oregun. The interevent time for such an event, which seems to be hundreds uf years if it could happen at all, depends strongly on the fraction of the relative plate motion that uceurs as seismic rupture rather than aseismic

Aki expressed optimism that a theory of earthquake prediction is about to emerge, in which tectonic loading rates, the friction law for faults and the distribution of heterogeneities along the fault surface (asperities and barriers) would all be taken into account. He emphasized the value of observations of changes in attenuation revealed by changes in the rate of decay uf the codas of local earthquakes as evidence of the changes in the distribution of small-scale heterogeneities and therefore as an important precursor.

Estimates of probabilities of occurrence of great carthquakes along various portions of the San Andreas fault developed independently by the Lamont group and by the U.S.G.S. were reviewed. There is strong agreement that an carthquake in the M6.2 range is highly likely in the Parkheld region in the next 20 years, and the most likely place for a great earthquake in the next lew decades is along the southeastern portion uf the 1857 break. Ishibashi has proposed a "West Suganti Thrust," along which slip occurs with great regularity at about 70 year intervals, the last being in 1923. He postulates that slip on this plane precedes great earthquakes to the southwest, along the uruga Bay thrust. His conclusion is that a large earthquake will occur on the West Sagami Thrust in the 1990's, followed by the expected great Tokai earthquake within a lew

Ishibashi also introduced to the seminar an idea recently proposed by K. Nakamura: the plate boundary between the North American and Eurasian Plates passes through cettral Honshu, possibly along the Fossa Magnal

Localized deformations of the crust, observable by a variety of techniques, may be the key to future earthquake predictions. Geodetic methods for earthquake dynamics range from conventional surveying techniques through a variety of Instruments for point measurements (till, strain, gravity) to spare-based observations using lung baseline interferometry and laser ranging to satellites. Most of the papers in this area emphasized measurement techniques rather than examples of field data. Y. Hingiwara did discuss the dependence of the rate of change of gravity with height on the mode of local uplift. M. Zoback related in situ stress measurements near the faults to observations of crustal deformations and associated

Monitoring local seismicity has been one activity in prediction research for years. The series of papers on this subject emphasized efficiency of the operation, with digital data, rapid data transmission, and automatic event location as key elements in modern practice in both the United States and Japan.

Case histories of precursors are still the basis of the search for a practical prediction eclinology. Examples of precursors, some well documented, others more speculative, were offered in reviews by Yamakawa, Mogi, and Wyss. Quiescence as defined by Wyss, or Mogl's gap of the second, is still a promising procursor that is derived from the analysis of an earthquake catalog. Strain events, b value changes, and earthquakes swarms or clusters hare all appeared as anomalies prior to larger events. Wyss has put together a carefully derived story of a number of precursors to the 1975 Hawaiian earthquake. This may well be the best case of observation of . simultaneous precursors with enough backup information to provide a basis for understanding them. At the same time, Wyss

recognizable precursors in the data available for the 1979 imperial Valley earthquake. Although electrical resistivity and geomagnetic anomalies have not provided the powerful tool for prediction once anticipated they are useful for outlining the details of

laults. Yukutake associates a low resignivity within the lault zone with harming, with some combination of water partent and higher temperature responsible for the anomalies. By any in reased pore pressure has been associated with its reased seisming, an association of lowered resistivity with increased earthquake activity is suggested.

The outlook for a major seismic event or videanism in the Lung Valley region was discussed by Hill, with special attention to the local medianisms of some of the earthquaker The lirst motion patterns do not lit a simple dyuple couple pattern, and various explanations were offered (and aired sobsequently in more detail at the AGU Fall Meetingl.

The ambitious Jajamese juogram of radon idiservations was described by Wakita. Some 25 sites are no upied by Tukro Daiversiy, the National Research Center for Disaster Prevention, and the Gordagical Survey of Japan. Metrorological factors and noise produced by pumping nearby wells serve to obscure possible precursory changes in the radon concentration. The most encouraging signal seen yet was the simultaneous change at three wells prior to a M6 event in Augus 1983, at distances of 80, 150, and 166 km. h cannot be claimed that cadon is a highly reliable presursor. Continuous hydrogen measurements for prediction have been started by M. Satio, and he showed some brief hydrugen spikes before some earthquakerin Long Valley.

Four papers on various aspects of the sociological and public policy aspects of earthquake predictions and their potential use in earthquake preparedness programs were offered. Of particular interest is the work of a committee of the Earthquake Engineering Research Institute of the United States in trying to learn the lessons offered by Japanese experience with the Large-Scale Earthquake Commermeasures Act of 1978 and the various kinds of responses and preparations being made in anticipation of the projected great earthquake in the Tokai

An important lesson from this seminar is the value to any group of scientists of taking time uut to synthesize the results of its recent work. We do tou little of this, as we push ahead eagerly to the next step. The America participants certainly learned much from the carefully prepared summaries and reviews delivered by their comptrymen, nominally for the henefit of the Japanese colleagues. Presumably, the Japanese attendees also learned from their close associates as well as from the Americans, Earthquake prediction is a tough problem in earth physics and chemistry. We are making progress, and the work done in the 6 years since the National Earthquake Hazards Reduction Program was started in the United States is paying off.

This meeting report was contributed by Carl Klaslinger, Cooperative Institute for Research in Environmental Sciences, University of Colorado of Boulder, Angliler, CO 80309.

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Mall Stop 601A, Ramplon, Virginis 23655) P. E.
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lett verticel rolumn amounts of No have been derived from loftered soler absorption spectra recorded near sunrise and susted with the 0.01-co. resolution Fourier tractsform interferometer it the Rational Solar Observatory or Ritl Pessisleration 2095 on Latitude 31.9° N) on February 22, 1981. The results show an increase in No concentration in the morning, tate afterhoon rabust about 40% higher than in the sarrhing, and a decrease in No concentration by the most of the most of the concentration prior to sunset. Demonstrate in No concentration prior to sunset. Demonstrate displayment of the concentration prior to sunset. Demonstrate in No concentration prior to sunset. Demonstrate in the Lotal sarrical column amount are compared with velues obtained from time-dependent photochemical calculations.

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PHOTOCHEMICAL PROBE CALCULATIONS
See 0173 Remote Sensing

J. Geophys. Rus., D. Paper 400787

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IS THE 1772% SOIL PROPILE
4. M. Sadeghi (Agrenous) department, University of
Arisanase, Reyelow(III), AR 72701), G. D. Hantuck,
U. P. Walts, B. D. Scott, and J. A. Pinna
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to investigate the ability of actroways demote
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the depth of drying levers within the bark moli(avaporation, drying mell, vater content, reder).
Neter Resout. Res., Paper 600478

## Seismology

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1 Strong Motton and Shock Wavas (ING OF GROUND MOTTON FARAMETERS, STATE OF STRESS AMO Gary (U.S. Seological Survey, 145 Middle Field Rd., 17, Menlo Park, CA 94025) The strong method of the strong state and one, where R is appeared by the strong method of the strong stron

ere eroperly laken into account than the ground solion parameters depend on the selseic moment he as expected from best scaling principles. That is, Rey midden and apa is independent of earthquaste size. Regression lines fill to observations, covering broad ranges in satisfic moment and focal depth, indicate that for extensional and compressional late into regimes, corresponding to normal and thrust or reversa fsutting earthquakes, raspectively, peek exceleration is given by

\*\*Romal: aft = -1.06 mos + 1.06 [MPa/Imil2]\*\*

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| Normal: sfa = -3.65 Mpa + 9.76 [MPa/Imil2]\*\*

| Thrust: sv/M<sub>0</sub> = 10<sup>-4</sup> [m<sup>2</sup>/sect][m-m] - 1/4 [4.534,82][m<sup>-1</sup>][2]\*\*

| For sirib silo estimptakes the data currantly are insufficient to define regression fils but such lines would definitely lie between those for the normal and thrust stress regions. These equations are appropriate for ground motion at small hyporenizal distance as recorded in a whole space. These equations are appropriate for ground motion at small hyporenizal distance as recorded in a whole space. These equations are appropriate for ground motion at small hyporenizal distance as recorded in a whole space. These equations are appropriate for ground motion at small hyporenizal distance as recorded in the whole space. The place that the same proportial depth, peek section of the same motion of the same has the same and the distance of continental ornat. The similarity in behavior of the opak acceleration in a compressional continuation and other crustopes and compression sequences For ground motion at small hyporentral distance as recorded in a whole pare. It follows that for Competable hypocentral death, peak acceleration in a compressioned tectomic regime, for example, such of the master United States, is a factor of about three greater than in an extension in regime, such as mayads, and for peak velocity a similar composition yields a factor of two difference. The similarity in behavior of the goak acceleration parameter to crustal strength, astimated from Byarrier's law of friction, with respect to depth and ctress thate, and takes that crustal strength is probably the factor governing the setimic source grocesses that give rise to the high-frequency peak ground motion. Analysis of the deak screleration take to have conceded a strength of the deak screleration that in the country of crustal strength suggests bounds on this ground motion garmeders, as econded at a typical surface site, that depend on stress state; specifically, a (normal 5.0.5 g and a thrustic 1.9 g, thus, the state of stress, as well as focal depth, clerity is an important factor is be taken into account in the presiction of ceismic ground action.

J. Geophym. Res., B. Paper 60000

### Social Sciences

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1057 SHABING WITH IRRIGATED AUBICULTURE: PROMISK WARSUS PERFORMANCE.

O. R. Franklin and B. k. Hagaram (Prospects Department, San Diago Stoke Welversity, San Diago, California, 92182). Tissected date from various federal water projects is analysed to determine the arrest of the deviation belowsh projected Private user, cost shelting and actual payments wolfacted, byldence is prosenced which above that irrigated appriculture is browly subsidized not colv with respect to capital appenditures but tise for operation, california controlled appenditures but the force of the substitute of substitute of the substitute of the

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Astrophysics,

and Astronomy 772D Electromagnetic Radiation SOLAR ULTSAVIOLET VARIATION RETVELN 1977 AND 1983 C. A. Hall (Aft Force Geophysics Laborstory, BodTord, Massechusetta, 09731) and G. P.

Bodford, Massechasett, 07:31) and G. P.
Anderson
A filth emajorement of the solar ultraviolation and the state of the strateghere has been added to four earlier ones. It confires the proviously published conclusion that photospheric solar traditions in the range 250-2579A has been essectially consist during the current solar selivity cycle. Chromospharic massections are in the Mglilline cures increased during rising scitivity and decreased again as the solity deciliand, [solar ultraviolet, solar tradismes, solar vertation).

J. Geophys. Ses., D. Paper 10040

## Tectonophysics

8(60 Piele Teologics PACTORR AFFECTING REISMIC MOMENT RELEASE RATES IN SUBDUCTION ZONES Eric T. Poleraon (Ospartment of Deophysics, Rianford Univer-nity, Rianford, California, 84305) and Teleuro Sono Lander California, 84305) and Teleuro Sonotalia.

Eric 7. Polarant (Department of Respirytion, Stanford University, Ranford California, 84305) and Telauno Sono
The amount of abelow selamic activity in subduction scene varios greatly from repice to region. We quantity this selamicity by calculating selamic moment release rates and anismic stip rates for 24 subduction sones. To calculate the moment release rates and anismic stip rates for 24 subduction sones. To calculate the moment release rates and saismic stip rates for 24 subduction sones. To calculate the moment release for each auditure plate threat-type events with a telescene and the sejamic release peterns. For subduction zones where the time windse of our sludy is not representative, the total moment release to corrected using informatics on repeat times. The moment release are compared with various subduction parameters in order to delearmine which factors influence the degree of poupling. These parameters include the age of the authousing lithosphere, absolute velocities of the upper and subducting plates, convergency velocity, and length, nearlinum depth, and dip of the Vedett-Benioff zone.

The moment release rate decreases as the age of the subducting lithosphere has seen, when the scose belonging to endage the subduction plate are considered. This age-variation content release relation in possistent for the sones in which the Peotifo, Coop. Philippine San. and holding plate was subduction plates are subducting plate and plate with subduction sones in which the Peotifo plate is subducting are much higher than for sones of other plates with similar age. The age-variation for sones of other plates with similar age. The age-variation for sones of other plates with similar age. The age-variation in the sone of the plates with similar angle plate, the age is the deminating factor affecting the already to be sone moment release relation holds among the sones which because the subduction plates the moment release to the relation that already to the age of the much solage that the subduction plates are re

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Bahamas and Cubs FZ'e in the region of southern Florids. Our glate reconstructions combined with chrono-stratigraphic and lithoetratigraphic information for the Guif of Maximo, southern Florida, and the Bahamas ledicate that the Guif was sealed off from the Atlantic waters until Chilovian time by an elevated Florida-Bahamas region. Rentricted infing of waters started in Collovian on a plate reorganization and cinoressed plate separation between thorth America and South America-Africo produced waterways into the Gulf of Mesico From the Pacific and possibly from the Atlantic. (Regnetic Enomalies, gravity anomalies, drillhols dete, pinternoonetructions). 1950, 2940, 5170, 9270.

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6000, Sidney, R.C. VOI. 402, Canda)

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Journal of Geophysical Research

Volume 69 Number B6 June 10, 1964

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398